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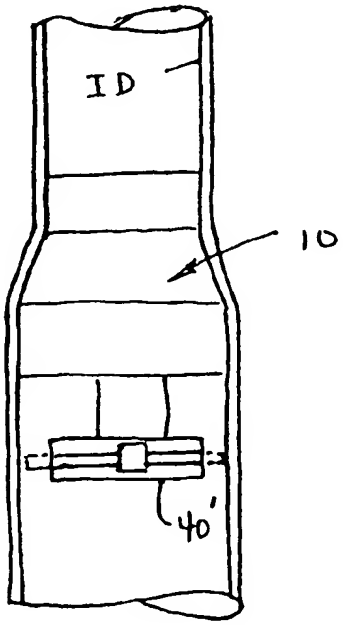
[Continued on next page]

(54) Title: RESIDUAL STRESSES IN EXPANDABLE TUBULAR CASING



(57) Abstract: An elongated section of steel tubing (30) has an outer circumferential surface and an inner circumferential surface defining an elongated axial passage through the tubing. An expansion mandrel (10) is moved through the tubing for radially expanding the tubing. An impact member (40) is provided for travel through the length of the axial passage. A plurality of movable impactors (42) are mounted to extend from the impact member. The impactors are driven for repeated contact with the inner circumferential surface as the impact member is moved through the tubing subsequent to the expansion mandrel for contacting the expanded inner circumferential surface along the entire length of the axial passage. Movement of the impactors is ultrasonic.

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ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/25742

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : B21C 37/30
US CL : 72/370.06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 72/370.06, 370.08, 53, 75

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2,929,741 A (STROCK et al.) 05 January 1960, (05-01-1960), whole doc.	23
—		—
Y		15-19
X	US 4,491,001 A (YOSHIDA et al.) 01 January 1985 (01-01-1985), whole doc.	1-3, 5-7, 21, 22
—		—
Y		4, 8, 15-19
Y	US 6,343,495 B1 (CHEPPE et al.) 05 February 2002 (05-02-2002), whole doc.	4, 8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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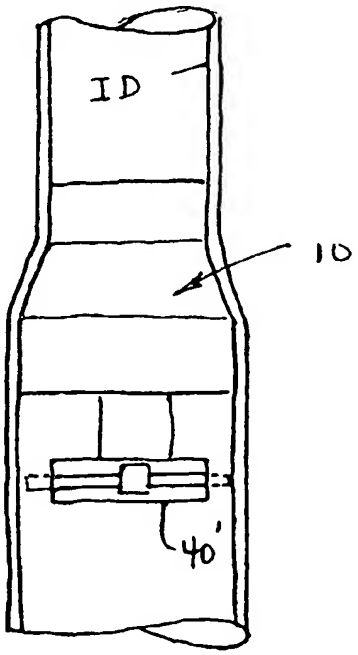

(57) Abstract: An elongated section of steel tubing (30) has an outer circumferential surface and an inner circumferential surface defining an elongated axial passage through the tubing. An expansion mandrel (10) is moved through the tubing for radially expanding the tubing. An impact member (40) is provided for travel through the length of the axial passage. A plurality of movable impactors (42) are mounted to extend from the impact member. The impactors are driven for repeated contact with the inner circumferential surface as the impact member is moved through the tubing subsequent to the expansion mandrel for contacting the expanded inner circumferential surface along the entire length of the axial passage. Movement of the impactors is ultrasonic.

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AMENDED CLAIMS

[received by the International Bureau on 27 July 2004 (27.07.04); new claims 24-49; remaining claims unchanged 1-23 (4 pages)]

moving an expansion mandrel through the tubing for radially expanding the tubing, the mandrel combined with the impact member so that the impactors contact the inner circumferential surface along the length of the axial passage after expansion.

21. An apparatus for treating steel tubing comprising:

an elongated section of steel tubing having an OD and an ID defining an elongated axial passage through the tubing; and

an impact member movably positioned in the passage, the impact member including means for impacting the ID of the tubing sufficient to increase negative tensile residual stress at the ID.

22. A method for treating steel tubing comprising:

providing an elongated section of steel tubing having an OD and an ID defining an elongated axial passage through the tubing; and

moving an impact member through the passage for impacting the ID of the tubing sufficient to increase negative tensile residual stress at the ID.

23. A method for treating steel tubing comprising:

manufacturing an elongated section of steel tubing having an OD and an ID defining an elongated axial passage through the tubing; and

positioning and moving a mandrel through the passage sufficient to increase negative tensile residual stress at the ID.

24. An apparatus for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

a support member adapted to extend into the wellbore casing;

an impact member coupled to the support member;

a plurality of movable impactors mounted to extend from the impact member; and

an impact driver connected to move the impactors into repeated contact with an interior surface of the wellbore casing which circumferentially surrounds the impact member.

25. The apparatus of claim 24 wherein the impactors are reciprocally movable.

26. The apparatus of claim 24 wherein the impact member is rotatably movable.

27. The apparatus of claim 24 wherein the movement of the impactors is ultrasonic.

28. A method for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

impacting an interior surface of the wellbore casing to adjust residual stresses within the wellbore casing.

29. The method of claim 28 further comprising:

reciprocally impacting an interior surface of the wellbore casing to adjust residual stresses within the wellbore casing.

30. The method of claim 28 further comprising:

rotatably impacting an interior surface of the wellbore casing to adjust residual stresses within the wellbore casing.

31. The method of claim 28 further comprising:

ultrasonically impacting an interior surface of the wellbore casing to adjust residual stresses within the wellbore casing.

32. An apparatus for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

an impact member;

a plurality of movable impactors mounted to extend from the impact member;

an impact driver connected to move the impactors into repeated contact with an interior surface of the wellbore casing circumferentially surrounding the impact member;

an expansion device coupled to the impact member movable along the interior surface for radially expanding the wellbore casing; and

the impact member positioned to follow the expansion device through the wellbore casing.

33. The apparatus of claim 32 wherein the impact member is in a housing separate from the expansion device.

34. The apparatus of claim 33 wherein the impactors reciprocate radially from the housing.

35. An apparatus for treating steel tubing comprising:

an impact member;

a plurality of movable impactors mounted to extend from the impact member;

an impact driver connected to move the impactors into repeated contact with an interior surface of the tubing circumferentially surrounding the impact member; and

an expansion device combined with the impact member and movable along the interior surface for radially expanding the tubing.

36. The apparatus of claim 35 wherein the expansion device and the impact member are in a common housing.

37. The apparatus of claim 36 wherein the impactors reciprocate from the housing.

38. The apparatus of claim 35 wherein the steel tubing comprises:
a wellbore casing positioned within a wellbore that traverses a subterranean formation.

39. A method for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:
providing an impact member for travel through the wellbore casing;
mounting a plurality of movable impactors to extend from the impact member;
driving the impactors for repeated contact with an inner circumferential surface of the wellbore casing;
moving an expansion device through the wellbore casing for radially expanding the expansion device; and
moving the impact member through the wellbore casing subsequent to the expansion device so that the impactors contact the expanded inner circumferential surface along the length of the wellbore casing.

40. The method of claim 39 further comprising:
providing a housing for the impact member.

41. The method of claim 40 further comprising:
reciprocating the impactors radially from the housing.

42. The method of claim 40 further comprising:
rotating the impact member.

43. The method of claim 40 further comprising:
reciprocating the impact members and rotating the housing.

44. A method for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:
providing an impact member for travel through the length of the wellbore casing;
mounting a plurality of movable impactors to extend from the impact member;

driving the impactors for repeated contact with an inner circumferential surface of the wellbore casing; and

moving an expansion device through the wellbore casing for radially expanding the wellbore casing, the expansion device combined with the impact member so that the impactors contact the inner circumferential surface along the length of the wellbore casing after expansion.

45. An apparatus for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

an impact member movably positioned in the wellbore casing, the impact member including means for impacting the ID of the wellbore casing sufficient to increase negative tensile residual stress at the ID.

46. A method for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

moving an impact member through the wellbore casing for impacting the ID of the wellbore casing sufficient to increase negative tensile residual stress at the ID.

47. A method for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

positioning and moving an expansion device through the wellbore casing sufficient to increase negative tensile residual stress at the ID.

48. A method for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

radially expanding and plastically deforming the wellbore casing within the wellbore; and

adjusting residual stresses within the radially expanded and plastically deformed wellbore casing.

49. A system for treating a wellbore casing positioned within a wellbore that traverses a subterranean formation, comprising:

means for radially expanding and plastically deforming the wellbore casing within the wellbore; and

means for adjusting residual stresses within the radially expanded and plastically deformed wellbore casing.